

**Program Name:** Shenandoah Salamander: Climate Change Casualty or Survivor?

**Suggested Grade Level:** 7<sup>th</sup> – 9<sup>th</sup> Life Science class

**Maximum Group Size:** 25 students (plus chaperones)

## Overview

Climate change can be defined as any significant change in the climate lasting for decades or longer. Climate patterns can vary naturally, but today's climate changes are being accelerated by human activity. Although scientists cannot yet predict with certainty what the long-term impacts from climate change will be, there is ample evidence that climate change effects are already being felt within national parks. Students will research climate change and the potential impact on two salamander species found in Shenandoah National Park, the endangered Shenandoah salamander and the more common red-backed salamander. Students will conduct field research on the red-backed salamander to compare the two species' habitat requirements and determine if climate change and competition for habitat are impacting the survival of the Shenandoah and red-backed salamanders.

## Objectives

Following the park experience and classroom activities, the students will be able to

1. Define *climate change* and list examples of natural and human-influenced contributors to climate change.
2. Conduct a salamander population study to determine habitat preferences and environmental conditions in Shenandoah National Park.
3. Assess/predict the potential impact of climate change and species competition on the survival of the Shenandoah and red-backed salamanders.
4. Determine ways people can reduce contributions to climate change.
5. Create a persuasive media message to educate others on the impacts of climate change and ways people can reduce their carbon footprint.

## Virginia Life Science Standards of Learning Addressed:

- LS.11 The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include
- a) food production and harvest;
  - b) change in habitat size, quality, or structure;
  - c) change in species competition;
  - d) population disturbances and factors that threaten or enhance species survival; and
  - e) environmental issues.
- LS.13 The student will investigate and understand that populations of organisms change over time. Key concepts include
- a) the relationships of mutation, adaptation, natural selection, and extinction;
  - c) how environmental influences, as well as genetic variation, can lead to diversity of organisms.

## Background Information

Climate change is any significant change in the climate lasting for decades or longer. Climate patterns (e.g. temperature, rain, snow) can vary naturally, but modern climate changes are accelerated by human activity. Although scientists cannot yet predict with certainty what the long-term impacts from climate change will be, there is ample evidence of climate change effects already being felt within national parks.

Major *greenhouse gases* - carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O) - trap some of the sun's heat in the atmosphere. At natural levels, this is enough heat to keep earth from freezing and helps to sustain life as we know it. Natural sources of greenhouse gases include plant respiration, volcanic eruptions, and natural decomposition of living things.

Human activities, such as burning fossil fuels (oil, coal, and natural gas), increase greenhouse gas levels. These extra gases trap even more heat, resulting in global warming and unprecedented rates of climate change. The total amount of greenhouse gas emissions caused by a person, household, event, or organization is called its "carbon footprint". This value can be calculated to help understand fossil fuel use and to help make personal choices to reduce the amount of carbon released into the environment.

Global warming is an increase of temperatures in the atmosphere and oceans around the world. Greenhouse gases are a major contributor to increasing global temperatures. This warming can change global climate factors such as temperature, humidity, rainfall, snowfall, and storm frequency and intensity.

Worldwide, there are many species residing in the *microclimates* of higher elevations that are at risk of extinction. One factor contributing to this risk could be increases in temperature due to climate change. Locally, scientists are predicting dramatic alterations in temperature and moisture gradients in the Appalachian Mountains in the future. Many of these higher elevation habitats that support unique ecosystems are located within the boundaries of Shenandoah National Park.

Salamanders are amphibians like frogs and toads. Most need water or moisture in which to reproduce. They live in a wide variety of habitats from swift-moving mountain streams to moist forests. In many habitats, they are the most abundant vertebrates. Of the more than 400 species of salamanders found worldwide, 130 to 150 live in North America. Over 40 percent of these are considered to be at risk. The greatest diversity of salamanders in the world is found in the Southeastern United States. Currently, 11 species are on the federal endangered or threatened species list in the United States.

Salamander habitat is being destroyed, modified, and fragmented, seriously diminishing the diversity and number of salamanders in the United States and around the world. Climate change is another factor that could impact their survival. Although these secretive creatures are unknown to many people, they are an important part of our natural world and in serious need of our protection.

## Shenandoah National Park Education Program

Shenandoah National Park (SNP) serves as a refuge for many species of animals otherwise pressured by human activities such as development and other land uses. There are over 200 resident and transient bird species, over 50 mammal species, 51 reptile and amphibian species, and over 35 fish species found in the park. Shenandoah is home to 14 species of salamanders. The Shenandoah salamander (*Plethodon shenandoah*) lives nowhere else on the planet except a few rocky mountaintops in the park and it is the only federally endangered animal species found in the park.

Across the country, scientists are studying potential impacts of a warming climate. Shenandoah National Park is collaborating with the Smithsonian Institution, University of Virginia, and the U.S. Geological Survey to assess potential climate change impacts on its high elevation species. Research and experiments focusing on the Shenandoah salamander are investigating how climate change might affect the species' use of habitat, feeding success, growth, and competition for habitat with red-backed salamanders. Additional research is being done on the two *color morphs* of the red-backed salamander to test the hypothesis that the "lead-backed" (unstriped morph) can withstand higher temperatures than the red-backed striped morph. This may mean that the lead-backed morph has a better chance of survival in a warmer climate.

This research will help resource managers understand the habitat needs of these and other species that are highly adapted to mountaintop living and to develop strategies that will help protect these species.

In this lesson, students will not be able to sample the Shenandoah salamander due to its rare and endangered status. They will be performing field investigations which duplicate the techniques that the Shenandoah salamander researchers used in their three-year study. Students will

- learn how to do a transect study on the more common red-backed salamander
- gather and analyze red-backed salamander data (size, location, behavior, and color morph)
- determine abiotic factors in red-backed salamander habitat (air temperature, humidity, and soil moisture and pH)
- compare their research results to the Shenandoah salamander research
- make conclusions/predictions on the survival of the Shenandoah salamander and the red-backed salamander in the park.

The mission of the National Park Service is to preserve and protect natural and cultural resources and leave them *unimpaired* for the enjoyment of future generations. This lesson will help students to understand how climate change and competition with the red-backed salamander could impact the survival of the endangered Shenandoah salamander. By doing this lesson, students will understand the plight of the Shenandoah salamander, will be able to educate others about the Shenandoah salamander and climate change, and will be able to make educated lifestyle choices that reduces their carbon footprint.

## Visiting a National Park

The mission of the National Park Service is to preserve and protect the natural and cultural resources of the nation for all people to enjoy. It is important for today's park visitors to practice good stewardship ethics and behaviors in order to pass these unique natural and historical treasures on to future generations in an *unimpaired* condition.

We recommend following **Leave No Trace** (LNT) principles when going on a field trip. There are seven LNT principles:

- Plan Ahead and Prepare
- Travel (and Camp) on Durable Surfaces
- Dispose of Waste Properly
- Leave What You Find
- Minimize Campfire Impacts
- Respect Wildlife
- Be Considerate of Other Visitors

Following these principles and park rules will help make your park visit a safe, successful learning experience while also caring for park resources.

<http://www.nps.gov/shen/planyourvisit/leavenotrace.htm>

## Vocabulary

- **Amphibian** - *a cold-blooded vertebrate that spends some time on land but must breed and develop into an adult in moist areas. Frogs, salamanders, and toads are amphibians*
- **Carbon footprint** - *the amount of carbon dioxide (CO<sub>2</sub>) we emit individually in any one-year period. CO<sub>2</sub> is produced from many sources and is the primary gas responsible for changes in our climate*
- **Climate change** - *long-term alteration in global weather patterns, especially increases in temperature and storm activity. These changes can result from natural and/or human-induced processes such as the greenhouse effect due to increased use of fossil fuels*
- **Competition** - *the process of trying to win or do better than others*
- **Ectothermic** - *body temperature varies with environmental surroundings; cold-blooded*
- **Endangered species** - *a species whose numbers are so few, or are declining so quickly, that the animal, plant, or other organism may soon become extinct. Endangered species are sometimes protected under national or international law.*
- **Endemic** - *native to or confined to a certain region*
- **Endothermic** - *maintaining a constant body temperature despite changes in the temperature of the environment; warm-blooded*
- **Extinction** - *condition in which a species no longer exists or is living*
- **Greenhouse gases** - *any of the atmospheric gases that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface. They include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (NO<sub>2</sub>), and water vapor. Although greenhouse gases occur naturally in the*

## Shenandoah National Park Education Program

*atmosphere, the substantially elevated levels especially of carbon dioxide and methane that have been observed in recent decades are directly related to human activities such as the burning of fossil fuels and the deforestation of tropical forests*

- **Habitat** – *the environment in which a plant or animal lives*
- **Microclimate** - *the average weather or the regular variations in weather over a period of years in a confined space or small geographic area*
- **Morph** – *natural variations in a gene, DNA sequence, or chromosome that have no adverse effects on the individual and frequently occur in the general population. The Shenandoah and red-back salamanders have two color morphs: striped – with a reddish dorsal stripe, and unstriped or “lead-backed” - with no dorsal stripe*
- **Preservation** - *the guarding of something from danger, harm, or injury*
- **Protection** - *the act of preventing something from being harmed or damaged, or the state of being kept safe*

### Materials

#### For pre/post-visit lessons

computer and internet access for research, Shenandoah National Park Natural Resources fact sheets [http://www.nps.gov/shen/naturescience/fact\\_sheets.htm](http://www.nps.gov/shen/naturescience/fact_sheets.htm), Shenandoah National Park climate change and salamander videos <http://www.nps.gov/shen/forteachers/classrooms/shenandoah-salamander-and-climate-change.htm>

KWL sheet (attached), Venn diagram sheet (attached), Salamander graphic organizer (attached), supplies/materials for culminating media message activity

#### For transect field study (4 groups of 4-5 students each)

artificial salamanders (or small photos) and various items to conceal artificial salamanders (**for practice transect at school only**), flagging tape or small marker flags, hand sanitizer (60-70% ethyl alcohol), zip-top plastic baggies, 4 reel-type 10 meter measuring tapes, 4 portable weather stations, 2 soil moisture and pH meters, field data sheets, clipboards and pencils

Optional:

- GPS device
- Cameras - video and/or still

### Time considerations

Pre-visit lessons: 90 minutes (up to 3 class periods)

Park Field Trip: 2 hours on site in Shenandoah National Park plus travel time

Post-visit lessons: 90 minutes (up to 3 class periods)

## **Pre-Visit Activities**

Complete the following pre-visit activities to prepare the students for their park field trip.

### **1. Shenandoah National Park Needs Your Help.**

Begin the KWL chart on Shenandoah National Park and the Shenandoah salamander.

*Tell the students, “Shenandoah National Park researchers need help in their study of the Shenandoah salamander (Plethodon shenandoah) which lives nowhere else on the planet except a few rocky mountaintops in the park. It is the only federally endangered animal species found in the park. It is suspected that competition with red-backed salamanders and the impacts of climate change could cause a serious decline in the population of the Shenandoah salamander. Park managers are responsible to preserve and protect species and all resources for future generations so the need for the scientific data is critical.”*

Ask students to think for a moment what they know about Shenandoah National Park, climate change, and the endangered Shenandoah salamander. Have students discuss their thoughts with a partner and then allow students to share their answers with the class. While students are sharing answers they can fill out the “Know – (K)” and “Want to Know” (W) column of the KWL sheet.

### **2. Climate change and Shenandoah salamander video(s)**

Using the park videos found at

<http://www.nps.gov/shen/forteachers/classrooms/shenandoah-salamander-and-climate-change.htm>, guide the students in a discussion of what they should find out to prepare for their research and field study.

- a. Watch the climate change video for an overview of climate change.
- b. Watch the Shenandoah salamander video, pausing at the listed intervals to allow time for discussion. Have the students add what they learn to the “L” section of their KWL sheet.

### **Segment 1, Time 0 – 2:13, Pause**

#### **Discussion Questions:**

- Why is the Shenandoah salamander a federally endangered species? (Rarity, restricted range)
- What makes microclimates or “islands in the sky” different? (support unique ecosystems and species not found elsewhere)
- Describe the habitat of the Shenandoah salamander and its needs (cooler temperatures and higher humidity).
- How do we know the earth’s temperature is changing? (climate models show a trend for future temperature increase)
- What is causing unprecedented climate change? (human activities are causing more greenhouse gas emissions)

**Segment 2, Time 2:13 – 4:10, Pause**

Discussion Questions:

- What will be the impact of climate change on the Blue Ridge Mountains in Shenandoah National Park? (rhetorical question posed)
- How will a changing climate alter the microclimates on the summits of Shenandoah's highest peaks? (rhetorical question posed)
- How will a changing climate affect the limited range where the Shenandoah salamander lives? (rhetorical question posed)
- Why has the Shenandoah salamander retreated up the mountainside causing a more isolated, restricted range? (cooler temperatures)
- What other factor is involved in putting pressure on the survival of the Shenandoah salamander? (competition for habitat from the red-backed salamander)
- What conditions are projected due to climate change? (warmer temperatures, periods of drought, violent storms, increased wildfires)
- How could climate change be a factor in the population decrease of the Shenandoah salamander? (increased temperatures in already small and isolated habitats)
- What are the options for the future of the Shenandoah salamander? (Adapt? Migrate? Extinction?)

Tell the students that scientists are conducting research to determine the environmental conditions in high elevation habitats necessary for the survival of salamanders.

**Segment 3, Time 4:11 – 5:17, Pause**

Discussion Questions:

- Who are the partners in this research and what are they studying? (Shenandoah National Park, University of Virginia, US Geological Survey, Smithsonian Institution)
- What type of climate data is being collected and analyzed to predict the future of the climate in Shenandoah National Park? (temperatures over 75 years at Big Meadows weather station in Shenandoah National Park, temperature sensors ("hobos") on Hawksbill Mountain)

Tell the students: *"When we go to Shenandoah National Park, you will be conducting research and a habitat field study on the **red-backed salamander**. We will be doing our research on the red-backed salamander since it is in competition for habitat with the Shenandoah salamander. You will search for salamanders, measure them, and collect environmental data (air temperature, humidity, soil moisture and pH) where you find a salamander. Here is what researchers have been doing in Shenandoah National Park on the Shenandoah salamander so far."*

**Segment 4, Time 5:17 – 6:59, Pause**

Discussion Questions:

- What type of research is being done on the Shenandoah salamander in Shenandoah National Park? (mapping the range of the Shenandoah salamander)
- What is the purpose of the project? (studying the impact of temperature and moisture change on the Shenandoah salamander will help the National Park Service make good decisions about preserving and conserving this species)
- How are the habitat requirements of the Shenandoah salamander (*Plethodon shenandoah*) and the red-backed salamander (*Plethodon cinereus*) similar/different? (both like cool, humid areas, leaf litter, a little soil, invertebrates to eat, but the red-backed will occupy the best sites and appears to exclude the Shenandoah salamander. Within high elevation areas, the Shenandoah salamander seems to be able to tolerate drier habitats, mostly rock with less leaf litter and soil, which might lead to slightly warmer conditions.
- What are the two abiotic climate factors being studied that might be affecting the Shenandoah salamander? (increased temperature and decreased humidity)
- What biotic factors are being studied that might affect the Shenandoah salamander? (competition with red-backed salamander)

**Segment 5, Time: 7:00 – end**

Discussion Questions:

- What does the researcher mean by “looming stress of climate change”?
- What might be your idea for the best strategy for the protection and preservation of the Shenandoah salamander? ( open-ended discussion)
- What can people do now to protect this species for future generations? (Reference the Climate Change video previously shown)

**3. Screen Time! Background Research**

Explain to the students that they will be using **primary source** resources from Shenandoah National Park to do their research. Have them complete the attached Venn diagram to differentiate between the two salamanders and the salamander graphic organizer for recording characteristics of the Shenandoah salamander using information from the video(s), Shenandoah National Park fact sheets, and websites provided. Give a brief review of using credible websites and avoiding plagiarism. Explain that this is why they are using the selected sites.

Tell the students: *“Now that we know about the park’s research, we need to prepare for our field experience. We will compare and contrast the red-backed salamander and the Shenandoah salamander using a Venn diagram. Visit at least three websites and make notes on each species on your Venn diagram. Work with a partner to compare and contrast these two species. Next, complete a Shenandoah salamander graphic organizer with species notes. When finished, you may lightly color the*



## Shenandoah National Park Education Program

*salamander, making sure to use the correct colors for the salamander and so that you can still see your notes for later use.”*

Red-backed salamander info:

<http://www.nps.gov/shen/naturescience/amphibians.htm>  
<http://www.dgif.virginia.gov/wildlife/information/?s=020043>  
<http://arnoldia.arboretum.harvard.edu/pdf/articles/1889.pdf>  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Taxonomy&bova=020043](http://www.vafwis.org/fwis/booklet.html?Menu=_.Taxonomy&bova=020043)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Status&bova=020043](http://www.vafwis.org/fwis/booklet.html?Menu=_.Status&bova=020043)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Life+History&bova=020043](http://www.vafwis.org/fwis/booklet.html?Menu=_.Life+History&bova=020043)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Occurrence&bova=020043](http://www.vafwis.org/fwis/booklet.html?Menu=_.Occurrence&bova=020043)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Environmental+Associations&bova=020043](http://www.vafwis.org/fwis/booklet.html?Menu=_.Environmental+Associations&bova=020043)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Habitat&bova=020043](http://www.vafwis.org/fwis/booklet.html?Menu=_.Habitat&bova=020043)  
[http://www.virginiaherpetologicalsociety.com/amphibians/salamanders/eastern-red-backed-salamander/red-backed\\_salamander.htm](http://www.virginiaherpetologicalsociety.com/amphibians/salamanders/eastern-red-backed-salamander/red-backed_salamander.htm)

Shenandoah salamander info:

[http://www.nps.gov/shen/naturescience/shenandoah\\_salamander.htm](http://www.nps.gov/shen/naturescience/shenandoah_salamander.htm)  
<http://www.dgif.virginia.gov/wildlife/information/?s=020045>  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Taxonomy&bova=020045](http://www.vafwis.org/fwis/booklet.html?Menu=_.Taxonomy&bova=020045)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Status&bova=020045](http://www.vafwis.org/fwis/booklet.html?Menu=_.Status&bova=020045)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Life+History&bova=020045](http://www.vafwis.org/fwis/booklet.html?Menu=_.Life+History&bova=020045)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Occurrence&bova=020045](http://www.vafwis.org/fwis/booklet.html?Menu=_.Occurrence&bova=020045)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Environmental+Associations&bova=020045](http://www.vafwis.org/fwis/booklet.html?Menu=_.Environmental+Associations&bova=020045)  
[http://www.vafwis.org/fwis/booklet.html?Menu=\\_.Habitat&bova=020045](http://www.vafwis.org/fwis/booklet.html?Menu=_.Habitat&bova=020045)  
[http://www.virginiaherpetologicalsociety.com/amphibians/salamanders/shenandoah-salamander/shenandoah\\_salamander.htm](http://www.virginiaherpetologicalsociety.com/amphibians/salamanders/shenandoah-salamander/shenandoah_salamander.htm)

Collect the students' KWL sheets, Venn diagrams, and Shenandoah salamander graphic organizers. Display the graphic organizers around the classroom room as cues for their field trip preparation. You will hand all three activity sheets back to them at a later time for use in creating multimedia presentations and public service messages.

#### **4. Field Research Prep!**

The students will be conducting research and a habitat study on the commonly found red-backed salamander modeled on the Shenandoah salamander research done in Shenandoah National Park. Review the goals of the park research a) to determine what affect changing climate factors such as temperature and moisture conditions may have on high elevation habitats and b) how competition with the closely related red-backed salamander may impact the survival of the Shenandoah salamander.

Option: Have the research teams develop a hypothesis statement on the habitat requirements of the red-backed salamander. What conditions do they expect to find

## Shenandoah National Park Education Program

and what environmental conditions would impact its survival? Remember the hypothesis should be an 'If....., then.....' statement.

Explain that the salamander researchers use a transect sampling technique. Transect techniques involve sampling along a line. There are many variations, but most involve stopping at intervals along that line and collecting data, i.e., searching under rocks, logs, and leaf litter for salamanders. Data is recorded at every location in which a salamander is found. Even if no salamanders are found along the transect, temperature, humidity, and soil readings are still recorded. The students will practice this sampling technique before going into the field.

Transect Sampling Procedure	
1.	Select a location where the transect line will cross several potential salamander hiding places.
2.	Survey the study area for any potential safety concerns such as poison ivy, stinging nettle, ant/insect nests, other animals such as snakes, or broken overhanging limbs. Look carefully above and around each rock, log, or leaf litter that you will search under
3.	From a starting point, decide a compass direction line using a GPS unit. Record the direction and measure a 10 meter line in that direction for the study transect line.
4.	Find and record the latitude/longitude coordinates of starting point using a GPS.
5.	Keep the measuring tape or string transect on the ground to keep the sampling in a straight line. Mark each end of transect line with flagging tape or marker flags.
6.	Sanitize your hands to prevent contamination of the study site or organisms.
7.	Search for salamanders within one-half meter along either side of the transect line (10 square meters).
8.	Turn over rocks and logs and leaf litter using the proper searching/handling protocol.
9.	For each salamander found, measure and record required data in pencil (pen ink can run if it gets wet). Record up to 15 samples.
10.	Document on data sheet if no salamanders are found.

Salamanders must be handled with care. Provide this background information and review proper handling procedures.

*An amphibian's thin, moist skin absorbs oxygen from the atmosphere and the skin can also absorb anything else that it comes into contact with. If you have perfume, insecticide, hand lotion, or even soap residue on your hands when you handle the salamander, it will absorb whatever is on your skin, perhaps with fatal results. When you handle a salamander, you may also transfer diseases to the animal from your hands. Therefore, use an appropriate 60-70% ethyl alcohol sanitizer on your hands prior to sampling in any salamander habitat.*

*In addition, compared to the ambient temperature of a salamander or frog, your hands are hot. The heat from your clean hands and the stress of being handled*

## Shenandoah National Park Education Program

*can actually cause unnecessary stress or death to the salamander. Over-handling can rub off the amphibian's protective mucous coating on the skin. This mucous provides anti-bacterial and anti-fungal protection to the amphibian to prevent infection and illness. Therefore, direct contact with the salamanders' skin should be avoided. You will be using re-sealable plastic baggies to handle the salamanders and take measurements.*

How to Search For and Handle Salamanders	
a.	Sanitize your hands to prevent contamination of the study site or organisms.
b.	Search under all cover objects by gently and slowly pulling the rock, log, or leaf litter TOWARDS YOU with both hands. This will provide an escape route for animals that might be there and will be a safety barrier for you.
c.	As you slowly pull the rock/log/leaves toward you, quickly look under it. Gently place the rock, etc., in a safe location.
d.	When a salamander is found, record its location in meters along your transect from the starting point.
e.	Turn the plastic baggie inside out and place your hand inside. Gently scoop up the salamander into the baggie and invert to seal the bag slightly to contain the salamander. Avoid holding it in your hands very long as your hot hand may be uncomfortable.
f.	Replace the rock/log/leaves under which you found the salamander.
g.	Hold the bag by the zipper top. Gently place the plastic bag on a flat surface and quickly measure the salamander's length in cm. Record on data sheet.
h.	After measuring the salamander, open the bag and release it next to the rock/log/leaves that you have replaced without holding it in your hand. It will most likely scoot safely under the cover avoiding light and seeking dampness.

### Conduct Practice Transect

To practice the sampling procedure and handling technique, randomly distribute artificial salamanders (or pictures) in an open area inside or on the school grounds. Conceal the salamanders under pails, plates, or other items that represent rocks/logs/leaves.

Divide students into four research teams. Review the data collection sheet. Within each team, assign tasks for searching, measuring, and recording data. Rotate assignments if desired. Students will lay out a transect line, search for "salamanders", take measurements, and record data while practicing proper searching and handling techniques.

- 5. Begin final preparation and planning for the class field trip to Shenandoah National Park.** Schedule your field trip with the Shenandoah National Park Education Office. Make arrangements for transportation and chaperones. Remind students about the time and date, appropriate dress, personal needs, and behaviors expected for the field trip.

### Shenandoah National Park Field Trip

## Shenandoah National Park Education Program

The in-park program will generally take a minimum of 2 hours. Plan for adequate travel time from your school to meet the ranger(s) at the scheduled time and location in the park. For an effective learning experience, please remember the following:

- Bring enough competent chaperones to assist on the field trip. The park requires 1 adult for every 10 students.
- Review appropriate dress for the cooler temperatures on the mountain and behavior expectations for the field trip.
- Plan for lunch or snacks. School groups are welcome to picnic in the park after the program. Picnic areas offer picnic tables and restrooms, but there are no shelters for inclement weather.

### **Research in Shenandoah National Park!**

1. Meet the park ranger at the scheduled time and location in Shenandoah National Park. Have the students share with the ranger what they have learned about climate change and the Shenandoah salamander and what they hope to discover on the field trip.

2. **Red-backed Salamander Transect Study**

At the field research site, the ranger will guide the students to follow the sampling procedures practiced at the school. Divide students into the four research teams, review sampling and salamander handling procedures, and distribute transect study equipment and materials. Review task assignments for searching, measuring, and recording data. Students will lay out their transect line, search for salamanders, take measurements, and record data while practicing proper searching and handling techniques. When completed, each team will keep their data record sheets for analysis back in the classroom.

### **Post-Visit Activities**

Following your field trip to Shenandoah National Park, use as many of the following post-visit activities as possible to conclude the unit of study. Complete the **Program Evaluation Form**. Return the program evaluation and copies of student work to:

**Shenandoah National Park**  
**3655 US Hwy 211 East**  
**Luray, VA 22835**  
**Attention: Education Office**

1. **Field Data Analysis**

Have the student research teams analyze their data collected in the field and make conclusions about the red-backed salamanders found in that area. What were the abiotic conditions at the transect site (air temperature, relative humidity, soil moisture and pH)? Were any salamanders found? Were they active? Were both red-backed color morphs found and how many of each type? Were other salamander species found? If no salamanders were found, propose possible reasons why. Did the field data support what was expected (hypothesis statement)? Design and construct charts and graphs to report findings.

2. **Putting All The Pieces Together**

## Shenandoah National Park Education Program

Return KWL, Venn diagram, and graphic organizer sheets to students. Have students review these documents with a “think/pair/share” activity focusing on these talking points:

- How are the two salamanders alike in appearance and behavior?
- Where do they live? What habitats do the two salamanders prefer?
- Where did we find red-backed salamanders?
- Did they all look alike? Were any other species of salamanders found?
- What were the temperature, humidity, and soil readings in the transect area?
- Why didn't we find Shenandoah salamanders in our study area?

Next, lead a discussion on what the students learned about climate change, the two salamander species, and their transect study experience. Have the students answer the following:

- What is the relationship between red-backed salamanders and Shenandoah salamanders in Shenandoah National Park?
- If climate conditions change (increase in temperature and reduction in humidity), what might happen to the Shenandoah and red-backed salamanders?
- Where could the Shenandoah salamander go to find suitable (cooler, wetter) habitat? Would it still compete for habitat with the red-back salamander?
- What could park resource managers do to protect/preserve necessary habitat for the endangered Shenandoah salamander, as well as the common red-backed salamander?
- If there was a major change in your community, such as a new road, housing development, or shopping center, how would the habitat change for the residents (plants, animals, and people)? Could they all adapt to the changes?
- How can citizens help improve habitats, even those far from their own community?
- What can citizens do to reduce their contributions to climate change that would help to improve environmental conditions and protect/preserve habitats for endangered species?

### **3. Investigate how humans contribute to climate change**

Have the students calculate their own “Carbon Footprint”. Have them *create a pledge* to make lifestyle choices that can reduce their carbon footprint and contributions to climate change.

<http://epa.gov/climatechange/kids/calc/index.html>

### **4. Spread the Word about the Shenandoah salamander and climate change**

Now that students know about the Shenandoah salamander and the National Park Service's concern for its fragile situation, in what ways can the public be informed about climate change, the Shenandoah salamander, and the importance of preserving the high elevation habitats where it lives? Brainstorm a list of ideas for informative and persuasive media messages. Possible topics include:

- the Shenandoah salamander is an indicator species of high elevation ecosystem degradation possibly due to changes in the climate

## Shenandoah National Park Education Program

- the research being done in Shenandoah National Park is investigating how climate change may affect the Shenandoah salamander and other high elevation ecosystems
- the importance of reducing the use of fossil fuels to reduce human-caused climate change (i.e. increased global temperature and CO<sub>2</sub> levels)

Working individually or in groups, have the students create a public service type message or a program to present to the school board, PTA, park managers, or local citizens' groups. Use multimedia programs such as Glogster, Powerpoint, Voicethread, Photostory, or social media to create a podcast, movie, or publication. These programs should demonstrate students' views on the importance of preserving high elevation habitats and the Shenandoah salamander, and ways that individuals can reduce the use of fossil fuels to slow down climate change.

### Assessment

1. Completed KWL chart
2. Completed Shenandoah salamander graphic organizer
3. Completed Venn diagram
4. Ability to follow scientific investigation procedures
5. Analysis of Field Data Sheet
6. Public Service Media message
7. Carbon Footprint analysis and pledge

### Going Further

1. Use this lesson's research procedures to sample for red-backed salamanders on the school site or nearby park area and compare with their park sample. Be sure to get necessary permission to collect data at that site and return all collected animals.

2. Research other resource issues in Shenandoah National Park

#### Air and Water Quality

- Acid Deposition
  - [http://www.nps.gov/shen/naturescience/acid\\_deposition.htm](http://www.nps.gov/shen/naturescience/acid_deposition.htm)
- Ozone
  - [http://www.nps.gov/shen/naturescience/gaseous\\_pollutants.htm](http://www.nps.gov/shen/naturescience/gaseous_pollutants.htm)
- Visibility and Haze
  - [http://www.nps.gov/shen/naturescience/visibility\\_and\\_haze.htm](http://www.nps.gov/shen/naturescience/visibility_and_haze.htm)
- Water Quality
  - <http://www.nps.gov/shen/naturescience/waterquality.htm>

#### Invasive Species

- Hemlock trees/Woolly adelgid
  - <http://www.nps.gov/grsm/naturescience/hemlock-woolly-adelgid.htm>
  - <http://www.nps.gov/biso/naturescience/hwa.htm>
- Hardwood forests/Gypsy moth
  - <http://www.nps.gov/shen/parknews/shenandoah-national-park-to-employ-aerial-spraying-against-gypsy-moth.htm>

## Shenandoah National Park Education Program

- <http://www.fs.fed.us/ne/morgantown/4557/gmoth/>
- Ash trees/Emerald Ash borer
  - [http://home.nps.gov/shen/planyourvisit/firewood\\_eab.htm](http://home.nps.gov/shen/planyourvisit/firewood_eab.htm)
  - <http://na.fs.fed.us/fhp/eab/>
- 3. Investigate “success stories” of other imperiled species
  - Peregrine Falcon
    - <http://www.nps.gov/shen/naturescience/falcon.htm>
  - Bald Eagle
    - <http://ngm.nationalgeographic.com/ngm/0207/feature2/index.html>
- 4. Investigate the research on whether the lead-backed color morph of the red-back salamander is more likely to survive than the striped morph in a warmer climate.  
<http://arnoldia.arboretum.harvard.edu/pdf/articles/1889.pdf>
- 5. Research other national parks that have serious resource management challenges and report on those to the class.

### **Related Virginia Standards of Learning Activities**

#### Pre-visit

Apply the scientific process to investigate and sample the population of red-backed salamanders. Students will be able to translate that information as it relates to the hypothesis that human-induced climate change is adversely affecting the population of Shenandoah salamanders.

- Virginia LS.1: The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations

#### On-site

Calculate, then do averages of the red-backed salamander numbers per combined linear meters in the sampling areas. Calculate the mean and average size (length) of the salamanders found in each sampling area, and in all areas combined.

- Virginia Mathematics 7.12: The student will represent relationships with tables, graphs, rules, and words.

#### Post-visit

Students will discuss their findings

- Virginia Oral Language English 7.1: The student will give and seek information in conversations, in group discussions, and in oral presentations.

Students will develop a multimedia presentation and present at science fair or school assembly:

- Virginia Oral Language English 7.3: The student will describe persuasive messages in non-print media, including television, radio, and video.

Students will write an editorial for submission to local newspaper.

- Virginia Writing 7.8: The student will develop narrative, expository, and persuasive writing.

## References and resources

### **Shenandoah National Park primary sources on the internet**

"Shenandoah Salamander." Shenandoah National Park, National Park Service. Web. 2013. [http://www.nps.gov/shen/naturescience/shenandoah\\_salamander.htm](http://www.nps.gov/shen/naturescience/shenandoah_salamander.htm)

"Climate Change and Shenandoah Salamanders." Natural Resource Fact Sheet. Shenandoah National Park, National Park Service. Web. 2013. [http://www.nps.gov/shen/naturescience/upload/SHEN\\_NR\\_104\\_Climate\\_Change\\_and\\_Shenandoah\\_Salamanders.pdf](http://www.nps.gov/shen/naturescience/upload/SHEN_NR_104_Climate_Change_and_Shenandoah_Salamanders.pdf)

"Shenandoah Salamander Monitoring Protocol." Natural Resource Fact Sheet. Shenandoah National Park, National Park Service. Web. 2013. [http://www.nps.gov/shen/naturescience/upload/SHEN\\_NR\\_105\\_Shenandoah\\_Salamander\\_Monitoring\\_Protocol.pdf](http://www.nps.gov/shen/naturescience/upload/SHEN_NR_105_Shenandoah_Salamander_Monitoring_Protocol.pdf)

### **Shenandoah National Park Maps**

<http://www.nps.gov/shen/planyourvisit/maps.htm>

### **Climate change**

National Park Service (NPS). Web. 2013. <http://www.nps.gov/subjects/climatechange/index.htm>

Environmental Protection Agency (EPA). Web. 2013. <http://www.epa.gov/climatechange/>  
<http://www.epa.gov/climatechange/kids/index.html>

National Oceanic and Atmospheric Administration (NOAA). Web. 2013 <http://www.climate.gov/>  
<http://www.cpc.ncep.noaa.gov/>

National Aeronautics and Space Administration (NASA). Web. 2013 <http://climate.nasa.gov/>  
<http://pmm.nasa.gov/science/climate-change>  
<http://climatekids.nasa.gov/>

Yale University. "Yale Project on Climate Change Communication." Web. 2013. <http://environment.yale.edu/climate/>



### **Salamander Information**

David, Bishop, and Haas Carola. "Sustaining America's Aquatic Biodiversity - Salamander Biodiversity and Conservation." Virginia Cooperative Extension. Department of Fisheries and Wildlife Sciences, Virginia Tech, 2009.

<http://pubs.ext.vt.edu/420/420-528/420-528.html>

#### **Red-backed salamander**

"*Plethodon cinereus*, Eastern Red-backed Salamander." Animal Diversity Web. University of Michigan. Web. 2013.

[http://animaldiversity.ummz.umich.edu/site/accounts/information/Plethodon\\_cinereus.html](http://animaldiversity.ummz.umich.edu/site/accounts/information/Plethodon_cinereus.html)

"Species Information: Eastern Red-backed Salamander (*Plethodon cinereus*)." Virginia Department of Game and Inland Fisheries, Web. 2013.

<http://www.dgif.virginia.gov/wildlife/information/?s=020043>

"Salamander, Eastern Red-backed." Virginia Fish and Wildlife Information Service, Web. 2013.

<http://www.vafwis.org/fwis/booklet.html?Menu=.Taxonomy&bova=020043&version=15684>

"Eastern Red-backed Salamander (*Plethodon cinereus*)." Virginia Herpetological Society, web. 2013.

[http://www.virginiaherpetologicalsociety.com/amphibians/salamanders/eastern-red-backed-salamander/red-backed\\_salamander.htm](http://www.virginiaherpetologicalsociety.com/amphibians/salamanders/eastern-red-backed-salamander/red-backed_salamander.htm)

#### **Shenandoah salamander**

Species Information: Shenandoah salamander (*Plethodon shenandoah*)." Virginia Department of Game and Inland Fisheries, Web. 2013.

<http://www.dgif.virginia.gov/wildlife/information/?s=020045>

"Salamander, Shenandoah." Virginia Fish and Wildlife Information Service. Web. 2013.

<http://www.vafwis.org/fwis/booklet.html?&bova=020045&Menu=.Taxonomy&version=15684>

"Shenandoah Salamander (*Plethodon shenandoah*)." Virginia Herpetological Society, Web. 2013.

[http://www.virginiaherpetologicalsociety.com/amphibians/salamanders/shenandoah-salamander/shenandoah\\_salamander.htm](http://www.virginiaherpetologicalsociety.com/amphibians/salamanders/shenandoah-salamander/shenandoah_salamander.htm)

### **Air Quality**

"Air Pollution - Its Nature, Sources, and Effects." Shenandoah National Park, National Park Service. Web. 2013.

<http://www.nps.gov/shen/naturescience/airpollution.htm>

### **Invasive Species**

"Non-native Species." Shenandoah National Park, National Park Service. Web. 2013.  
<http://www.nps.gov/shen/naturescience/nonnativespecies.htm>

#### **Woolly adelgid and hemlock trees**

"Forest Health Protection—Hemlock Woolly Adelgid." U.S. Forest Service, Web. 2013.  
<http://na.fs.fed.us/fhp/hwa/>

"Eastern Hemlock." Shenandoah National Park, National Park Service. Web. 2013.  
[http://www.nps.gov/shen/naturescience/eastern\\_hemlock.htm](http://www.nps.gov/shen/naturescience/eastern_hemlock.htm)

#### **Gypsy moth and hardwood trees**

"Forest Insects & Disease (Nonnative Species)." Natural Resource Fact Sheet. Shenandoah National Park, National Park Service. Web. 2013.  
[http://www.nps.gov/shen/naturescience/upload/SHEN\\_NR\\_067\\_Forest\\_Pests\\_Exotic.pdf](http://www.nps.gov/shen/naturescience/upload/SHEN_NR_067_Forest_Pests_Exotic.pdf)

#### **Emerald Ash borer and ash trees**

"Emerald Ash Borer." U.S. Forest Service, Michigan State University, Purdue University and Ohio State University. Web. 2013.  
<http://www.emeraldashborer.info/>

"Firewood Ban." Shenandoah National Park, National Park Service. Web. 2013.  
[http://www.nps.gov/shen/planyourvisit/firewood\\_eab.htm](http://www.nps.gov/shen/planyourvisit/firewood_eab.htm)

### **Success Stories of other imperiled species**

#### **Peregrine Falcon**

U.S. "Peregrine Falcon." Shenandoah National Park, National Park Service. Web. 2013.  
<http://www.nps.gov/shen/naturescience/falcon.htm>

#### **Bald Eagle**

Eliot, John L. "Bald Eagles @ National Geographic Magazine." National Geographic, 2002.  
<http://ngm.nationalgeographic.com/ngm/0207/feature2/index.html>

### **Teacher resources**

K-W-L Chart Printout. Readwritethink.org. IRA/NCTE. Web. 2013.  
<http://www.readwritethink.org/classroom-resources/printouts/chart-a-30226.html>

Worksheets, Lesson Plans, Teacher Resources, and Rubrics. TeAch-nology.com. Teachnology, Inc. Web. 2013.  
<http://www.teach-nology.com/>

**Other print resources**

Cherry, Lynne, and Gary Braasch. "How We Know What We Know about Our Changing Climate: Scientists and Kids Explore Global Warming." Nevada City, CA: Dawn Publications, 2008.

Malnor, Carol. "A Teacher's Guide to How We Know What We Know About Our Changing Climate – Lessons, Resources, and Guidelines about Global Warming." Nevada City, CA: Dawn Publications, 2008.

Gershon, David. "Journey for the Planet: A Kid's Five Week Adventure to Create an Earth Friendly Life." Woodstock, NY: Empowerment Institute, 2007.

Harper, Michael, Paula Owen, and Gayle Reed. "Global Climate Change: Teachers' Resource Pack (secondary School Edition)." Manchester: ARIC, 1994.

Mathez, Edmond A. "Climate Change: The Science of Global Warming and Our Energy Future." New York: Columbia UP, 2009.

Schmidt, Gavin, and Joshua Wolfe. "Climate Change: Picturing the Science." New York: W.W. Norton, 2009.





## KWL Chart



Name: \_\_\_\_\_ Date: \_\_\_\_\_

In the first column, write what you already know about climate change and the Shenandoah salamander. In the second column, write what you want to know about climate change and the Shenandoah salamander. **After** you have watched the podcast and completed your research, write what you learned in the third column.

What I <b>K</b> now	What I <b>W</b> ant to Know	What I <b>L</b> earned

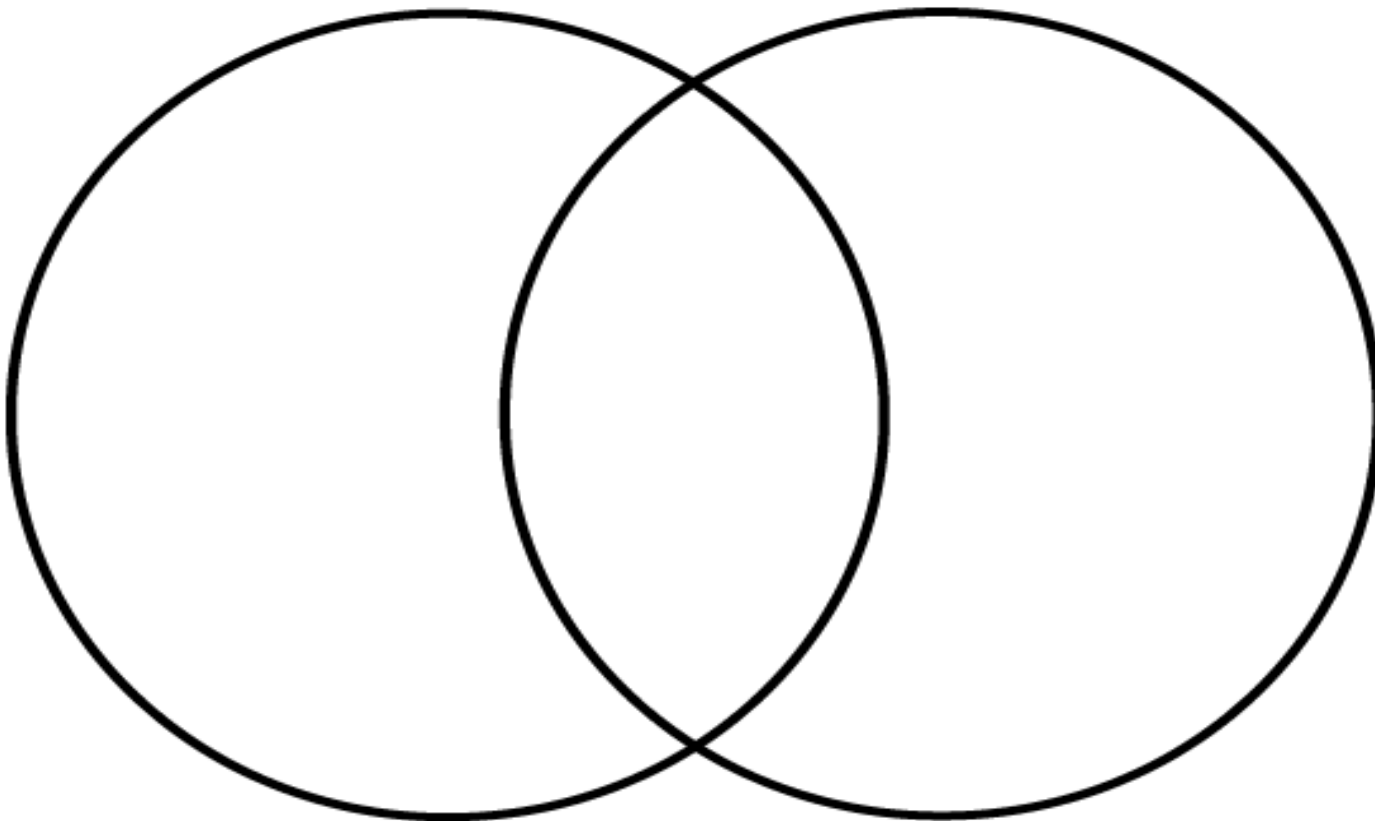
## Venn Diagram

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Use the Venn diagram to take notes. Compare and contrast the Shenandoah Salamander and the red-backed salamander. Include differences and similarities like habitat, food, temperature requirements and identifying physical characteristics

Shenandoah salamander

Red-backed salamander



## Salamander Graphic Organizer

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Use this graphic organizer to take notes as you complete your research on the Shenandoah salamander.



# Shenandoah National Park Education Program

## Transect Field Data Sheet

School: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_

Research Team: \_\_\_\_\_

Transect #: \_\_\_\_\_ Compass Direction: \_\_\_\_\_

Transect starting point: Latitude: \_\_\_\_\_ Longitude: \_\_\_\_\_

Air temperature: \_\_\_\_\_ Relative Humidity \_\_\_\_\_ Soil moisture \_\_\_\_\_ Soil pH \_\_\_\_\_

Weather (circle): Clear, partly cloudy, overcast Rain in the last 24 hours? Yes No

**Materials:** sanitizer, measuring tape, flagging tape or marker flags, field data sheet, clipboard, pencils, zip-top plastic baggies, small metric rulers, portable weather stations, soil moisture/pH meter, GPS unit.

### How to Search For and Handle Salamanders

- a. **Sanitize your hands to prevent contamination of the study site or organisms.**
- b. **Search under all cover objects by gently and slowly pulling the rock, log, or leaf litter TOWARDS YOU with both hands. This will provide an escape route for animals that might be there and will be a safety barrier for you.**
- c. **As you slowly pull the rock/log/leaves toward you, quickly look under it. Gently place the rock, etc., in a safe location.**
- d. **When a salamander is found, record its location in meters along your transect from the starting point.**
- e. **Turn the plastic baggie inside out and place your hand inside. Gently scoop up the salamander into the baggie and invert to seal the bag slightly to contain the salamander. Avoid holding it in your hands very long as your hot hand may be uncomfortable.**
- f. **Replace the rock/log/leaves under which you found the salamander.**
- g. **Hold the bag by the zipper top. Gently place the plastic bag on a flat surface and quickly measure the salamander's length in cm. Record on data sheet.**
- h. **After measuring the salamander, open the bag and release it next to the rock/log/leaves that you have replaced without holding it in your hand. It will most likely scoot safely under the cover avoiding light and seeking dampness.**

### Transect Sampling Procedure

1. Select a location where the transect line will cross several potential salamander hiding places.
2. Survey the study area for any potential safety concerns such as poison ivy, stinging nettle, ant/insect nests, other animals such as snakes, or broken overhanging limbs. Look carefully above and around each rock, log, or leaf litter that you will search under.
3. From a starting point, decide a compass direction line using a GPS unit. Record the direction and measure a 10 meter line in that direction for the study transect line.
4. Find and record the latitude/longitude coordinates of starting point using a GPS.
5. Keep the measuring tape or string transect on the ground to keep the sampling in a straight line. Mark each end of transect line with flagging tape or marker flags.
6. Sanitize your hands to prevent contamination of the study site or organisms.
7. Search for salamanders within one-half meter along either side of the transect line (10 square meters).
8. Turn over rocks and logs and leaf litter using proper the searching/handling protocol.
9. For each salamander found, measure and record required data in pencil (pen ink can run if it gets wet). Record up to 15 samples.
10. Document on data sheet if no salamanders are found.

# Shenandoah National Park Education Program

## Sampling Data Sheet

Sample #	Salamander Location: meters from start point	Size in cm – Snout to tip of tail	Color Morph: Striped or Lead-backed?	Salamander Notes/Behavior
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				